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CLAIMS

[Claim(s)]

[Claim 1] The probe arranged near the heating coil of a high-frequency-induction-heating machine so that the magnetic flux generated according to the eddy current which flows to the heated member which is the magnetic substance at the time of high-frequency induction heating might be detected as quantity of electricity, such as an electrical potential difference and a current, Process the electrical signal showing quantity of electricity which this probe detected, and change of the electrical signal corresponding to the transformation point of the physical-properties-organization by the high-frequency induction heating of a heated member is detected. Transformation point detection equipment of the heated member by the high-frequency induction heating characterized by having a transformation point detection means to send out the transformation point signal showing having reached at this transformation point.

[Claim 2] The high-frequency-induction-heating machine which has the heating coil which carries out induction heating of the heated member, In the hardening equipment by the high-frequency induction heating which has a cooling water supply means to supply the cooling water for quenching the heated heated member, and the control means which controls a high-frequency-induction-heating machine and a cooling water supply means The probe arranged near the heating coil of a high-frequency-induction-heating machine so that the magnetic flux generated according to the eddy current which flows to the heated member which is the magnetic substance at the time of high-frequency induction heating might be detected as quantity of electricity, such as an electrical potential difference and a current, Process the electrical signal showing quantity of electricity which this probe detected, and change of the electrical signal corresponding to the transformation point of the physical-properties-organization by the high-frequency induction heating of a heated member is detected. A transformation point detection means to have a transformation point detection means to send out the transformation point signal showing having reached at this transformation point, While controlling a high-frequency-induction-heating machine to input a transformation point detecting signal and to suspend heating of a heated member after predetermined time progress from the time of this input Hardening equipment by the high-frequency induction heating characterized by having the control means which controls a cooling water supply means to supply cooling water to a heated member after predetermined time progress from this halt.

[Claim 3] The high-frequency-induction-heating machine which has the heating coil which carries out induction heating of the heated member, In the hardening equipment by the high-frequency induction heating which has a cooling water supply means to supply the cooling water for quenching the heated heated member, and the control means which controls a high-frequency-induction-heating machine and a cooling water supply means The probe arranged near the heating coil of a high-frequency-induction-heating machine so that the magnetic flux generated according to the eddy current which flows to the heated member which is the magnetic substance at the time of high-frequency induction heating might be detected as quantity of electricity, such as an electrical potential difference and a current, Process the electrical signal showing quantity of electricity which this probe detected, and change of the electrical signal corresponding to the transformation point of the physical-properties-organization by the high-

frequency induction heating of a heated member is detected. A transformation point detection means to have a transformation point detection means to send out the transformation point signal showing having reached at this transformation point, While controlling a high-frequency-induction-heating machine to input a transformation point detecting signal and to suspend heating of a heated member after predetermined time progress from the time of this input A cooling water supply means is controlled to supply cooling water to a heated member after predetermined time progress from this halt. Hardening equipment by the high-frequency induction heating characterized by having the control means controlled so that it furthermore measures the heating time from heating initiation to the input of a transformation point detecting signal, and an alarm means emits an alarm, when the set point which this heating time defined beforehand is out of range.

[Claim 4] A heated member is steel and the transformation point is A3 of steel. The transformation point and a transformation point signal are A3. A3 showing having reached at the transformation point Transformation point detection equipment or hardening equipment of a heated member by any of [claim 1] - [claim 3] characterized by being a transformation point signal, or the high-frequency induction heating indicated to one.

[Claim 5] A heated member is steel and the transformation point is A2 of steel. The transformation point and A3 The transformation point and a transformation point signal are A2. A2 showing having reached at the transformation point A transformation point signal and A3 A3 showing having reached at the transformation point Transformation point detection equipment or hardening equipment of a heated member by any of [claim 1] - [claim 3] characterized by being a transformation point signal, or the high-frequency induction heating indicated to one.

[Claim 6] A probe is the transformation point detection equipment or hardening equipment of a heated member by any of [claim 1] - [claim 5] characterized by being the pick up coil arranged so that the magnetic flux which an eddy current generates might interlink, or the high-frequency induction heating indicated to one.

[Claim 7] A transformation point detection means has the differential circuit which detects the differential value of the electrical signal showing quantity of electricity, and the window comparator which detects whether it has fitted in the predetermined range in which the value of an electrical signal was defined beforehand, and the differential value of an electrical signal is zero. And transformation point detection equipment or hardening equipment of a heated member by any of [claim 1] - [claim 6] characterized by constituting so that the value of the electrical signal may send out a transformation point signal a condition [having fitted in the predetermined range], or the high-frequency induction heating indicated to one.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The block diagram showing the gestalt of operation of this invention.

[Drawing 2] The property Fig. showing the thermo cycle at the time of hardening realized according to the gestalt of operation of drawing 1.

[Drawing 3] The circuit diagram showing the concrete example of the transformation point detector of drawing 1.

[Drawing 4] A2 in drawing 3, and A3 Wave form chart for explaining the detection principle of the transformation point.

[Drawing 5] The property Fig. showing change of the die length and the MAG accompanying the temperature change of pure iron.

[Drawing 6] The explanatory view showing notionally the principle of high-frequency induction heating and this invention.

[Drawing 7] A2 which is the principle of this invention, and A3 Explanatory view showing the relation between the transformation point and the current generated by the flux reversal by the eddy current.

[Description of Notations]

1 High-frequency-Induction-Heating Machine

1a RF generator

1b Heating coil

1c Probe

3 Transformation Point Detector

3a A2 Transformation point detector

3b A3 Changing point detector

4 Control Section

5 Cooling Water Feeder

7 Alarm

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is applied in case especially a heating unit distinguishes whether it has reached at the predetermined organization transformation point about the transformation point detection equipment and hardening equipment of a heated member by high-frequency induction heating, and it is useful.

[0002]

[Description of the Prior Art] Heat-treatment of the metal using a high-frequency-induction-heating machine is a technique currently used widely in various industrial fields. This heats a heated member with the Joule's heat generated according to this eddy current, and performs hardening etc. while it makes the high frequency current act on the metal which is the heated member of a conductor about a sink and the alternating field which occur as a result at the heating coil of a high-frequency-induction-heating machine and generates an eddy current.

[0003] In this hardening, when a heated member is steel, for example, it is necessary to go that it is an austenite texture by heating. It is because it begins by supplying cooling water to the steel used as an austenite texture, and quenching this and a desired hardening degree of hardness is obtained.

[0004] Since the depth which the eddy current which specifies the hardening depth from the front face of a heated member produces on the other hand in hardening by high-frequency induction heating, i.e., the depth which decreases in an eddy current consistency to constant value, is influenced of the skin effect, it has the relation of a degree type (1).

[Equation 1]

$$\begin{array}{l} \text{渦電流の生ずる深さ} \\ (\text{渦電流密度が一定値に減る深さ}) \propto \frac{1}{\text{渦電流 (電源) 周波数} \times \text{透磁率} \times \text{電気伝導度}} \dots (1) \end{array}$$

[0005] Therefore, if a heated member is specified, since the permeability and electrical conductivity which are the physical constant of the proper are specified, they can select the hardening depth as a standard suitably theoretically by specifying a frequency. Then, the hardening depth has determined the frequency of the RF generator of a high-frequency-induction-heating machine as an index conventionally.

[0006] On the other hand, when high-frequency induction heating is performed, even if it suspends heating, the heat injected into the heated member according to the thermal conductivity which is the physical constant of a proper is transmitted to the deep part of a heated member. For this reason, hardening is actually made to a deep part a little rather than the hardening depth which can be theoretically found by the upper type (1) in many cases.

[0007] Then, conventionally, by the observation about many heated members and experience in which physical constants differ, it asks for the relation between heating time and heating power, and hardening condition (a degree of hardness / case depth), and a suitable thermo cycle is determined based on this

relation, and actual hardening is performed.

[0008]

[Problem(s) to be Solved by the Invention] In hardening by the high-frequency induction heating which starts the conventional technique like **** Since it depends on the actual measurement, the experience value, etc. determining this thermo cycle, A heated member and hardening conditions are accepted. It not only must determine a thermo cycle according to an individual, but Even in this case, it is necessary to fracture and inspect a part of heated member about whether the heating unit serves as an austenite texture with hardening carried out by the specific thermo cycle at predetermined hardening, i.e., the case of steel.

[0009] In carrying out two or more coincidence hardening especially using two or more heating coils (multi-coil), the replacement to other parts of the hardening data clarified by one specific place takes much destructive inspection.

[0010] Thus, there is a fault that management of the hardening quality takes great time amount and costs in hardening by high-frequency induction heating in the conventional technique.

[0011] This invention sets the following matter as the technical purpose in view of the above-mentioned conventional technique.

1) Offer the transformation point detection equipment of the heated member by the high-frequency induction heating which can detect easily that the heating unit of a heated member is in the predetermined organization condition at the time of hardening (if it is steel austenite texture).

2) Offer the hardening equipment by the high-frequency induction heating which can build the ideal thermo cycle using the detection result of 1.

3) Offer the hardening equipment by the high-frequency induction heating which can also detect easily the abnormal condition of hard sides, such as a defect of a heating coil, in addition to 2.

[0012] In having set up the purpose and considering the concrete configuration like ****, it was based on a following principle and following knowledge.

[0013] Drawing 5 is the property Fig. showing change of the die length and the MAG accompanying the temperature change of pure iron. if this drawing is referred to -- a clear passage -- magnetic strength -- A2 [about 770-degree C] the transformation point -- until -- fixed -- this A2 if the transformation point is exceeded -- rapid -- falling -- about 910-degree C A3 It continues till the transformation point, and if this is exceeded, it will become the constant value near the zero.

[0014] this -- A2 the transformation point -- until -- a ferromagnetic and A2 The transformation point and A3 during the transformation point -- paramagnetic material and A3 It is because it becomes non-magnetic material above the transformation point.

[0015] Here, the condition that hardening should realize is A3. It is in the condition of the gamma iron more than the transformation point. It is because pure iron serves as an austenite texture in the state of this gamma iron.

[0016] Therefore, A3 If having reached at the transformation point is detectable, it will be guaranteed that sufficient heating required for hardening was performed.

[0017] Drawing 6 is the explanatory view showing the principle of high-frequency induction heating notionally. As shown in this drawing (a), in high-frequency induction heating, the high frequency current is passed to heating coil 1b by RF generator 1a, and alternating field are formed. If this alternating field are made to act on the heated members W, such as steel which is the magnetic substance, as shown in this drawing (b), an eddy current E will be produced in this heated member W. And this eddy current E generates the field according to that magnitude. The field according to this eddy current E can be detected as magnitude of quantity of electricity (an electrical potential difference, current) generated in probe 1c arranged near the heating coil 1b.

[0018] therefore, change and A3 of quantity of electricity (an electrical potential difference, current) which are generated in probe 1c the transformation point -- related ***** -- if things are made -- A3 Having reached at the transformation point is detectable.

[0019] Then, A2 and A3 In the transformation point, induction heating of the heated member W which is the sample formed with steel materials was carried out by heating coil 1b under prediction that a

current should change suddenly, and when the current which flows to probe 1c at this time was measured, the wave as shown in drawing 7 was acquired. This current wave form is a thing at the time of supplying the high frequency current to heating coil 1b at the time of "ON" in this drawing, and suspending this supply at the time of "OFF."

[0020] It is based on this observation result and they are a current wave form, and A2 and A3. When the destructive inspection of the heated member W investigated relation with the transformation point, they are A2 and A3 all over drawing as prediction. The suddenly changing point of the current described as the transformation is A2 and A3, respectively. It has checked that it was the transformation point.

[0021] Thus, A2 and A3 It is thought that a current changes suddenly in the transformation point because iron changes from a ferromagnetic to paramagnetic material, physical properties change from paramagnetic material to non-magnetic material and the permeability which is a physical constant changes suddenly in connection with this like the above-mentioned.

[0022] Consequently, the heating unit of the heated member W is A2 and A3 by grasping the condition of the magnetic flux near the heating coil 1b by probe 1c. It became clear that it could detect to have reached at the transformation point.

[0023] That is, that the austenite texture which is in the organization condition which should be realized with heating at the time of hardening will be formed if it is the case of steel can detect by grasp of quantity of electricity like ****, without managing the temperature of a heating unit. Thus, the fact that it can guarantee having reached the austenite texture without being based on temperature management is A3. The impurity in steel is comparatively alike, the temperature corresponding to the transformation point changes more, and it is A3. It is convenient especially if it takes into consideration that there is no unique relation between the transformation point and the temperature of a heating unit. Incidentally, the more a carbonaceous content increases in steel, the more it is A3. Transformation point temperature falls.

[0024]

[Means for Solving the Problem] The configuration of this invention which attains the technical purpose based on the above-mentioned knowledge is characterized by the following point.

1) The probe arranged near the heating coil of a high-frequency-induction-heating machine so that the magnetic flux generated according to the eddy current which flows to the heated member which is the magnetic substance at the time of high-frequency induction heating might be detected as quantity of electricity, such as an electrical potential difference and a current, Process the electrical signal showing quantity of electricity which this probe detected, detect change of the electrical signal corresponding to the transformation point of the physical-properties-organization by the high-frequency induction heating of a heated member, and have a transformation point detection means to send out the transformation point signal showing having reached at this transformation point.

[0025] 2) The high-frequency-induction-heating machine which has the heating coil which carries out induction heating of the heated member, In the hardening equipment by the high-frequency induction heating which has a cooling water supply means to supply the cooling water for quenching the heated heated member, and the control means which controls a high-frequency-induction-heating machine and a cooling water supply means The probe arranged near the heating coil of a high-frequency-induction-heating machine so that the magnetic flux generated according to the eddy current which flows to the heated member which is the magnetic substance at the time of high-frequency induction heating might be detected as quantity of electricity, such as an electrical potential difference and a current, Process the electrical signal showing quantity of electricity which this probe detected, and change of the electrical signal corresponding to the transformation point of the physical-properties-organization by the high-frequency induction heating of a heated member is detected. A transformation point detection means to have a transformation point detection means to send out the transformation point signal showing having reached at this transformation point, While controlling a high-frequency-induction-heating machine to input a transformation point detecting signal and to suspend heating of a heated member after predetermined time progress from the time of this input, have the control means which controls a cooling water supply means to supply cooling water to a heated member after predetermined time

progress from this halt.

[0026] 3) The high-frequency-induction-heating machine which has the heating coil which carries out induction heating of the heated member, In the hardening equipment by the high-frequency induction heating which has a cooling water supply means to supply the cooling water for quenching the heated member, and the control means which controls a high-frequency-induction-heating machine and a cooling water supply means The probe arranged near the heating coil of a high-frequency-induction-heating machine so that the magnetic flux generated according to the eddy current which flows to the heated member which is the magnetic substance at the time of high-frequency induction heating might be detected as quantity of electricity, such as an electrical potential difference and a current, Process the electrical signal showing quantity of electricity which this probe detected, and change of the electrical signal corresponding to the transformation point of the physical-properties-organization by the high-frequency induction heating of a heated member is detected. A transformation point detection means to have a transformation point detection means to send out the transformation point signal showing having reached at this transformation point, While controlling a high-frequency-induction-heating machine to input a transformation point detecting signal and to suspend heating of a heated member after predetermined time progress from the time of this input A cooling water supply means is controlled to supply cooling water to a heated member after predetermined time progress from this halt. Furthermore measure the heating time from heating initiation to the input of a transformation point detecting signal, and when the set point which this heating time defined beforehand is out of range, have the control means controlled so that an alarm means emits an alarm.

[0027] 4) Setting to the above 1-3, a heated member is steel and the transformation point is A3 of steel. The transformation point and a transformation point signal are A3. A3 showing having reached at the transformation point It is a transformation point signal.

[0028] 5) Setting to the above 1-3, a heated member is steel and the transformation point is A2 of steel. The transformation point and A3 The transformation point and a transformation point signal are A2. A2 showing having reached at the transformation point A transformation point signal and A3 A3 showing having reached at the transformation point It is a transformation point signal.

[0029] 6) In the above 1-5, a probe should be the pick up coil arranged so that the magnetic flux which an eddy current generates might interlink.

[0030] 7) It is having constituted so that a transformation point signal's might be sent out a condition [having the differential circuit which detects the differential value of the electrical signal with which a transformation point detection means expresses quantity of electricity in the above 1-6, and the window comparator which detects whether it has fitted in the predetermined range in which the value of an electrical signal was defined beforehand, the differential value of an electrical signal being zero, and moreover the value of the electrical signal being settled in the predetermined range].

[0031] According to this invention of the above-mentioned configuration, by the probe, the magnetic flux by the eddy current of the hardening section of a heated member is changed into an electrical signal, and is detected. The sudden change section of the electrical signal detected here supports the transformation point of the hardening section, and a transformation point detection means detects this sudden change section.

[0032] Therefore, the transformation point signal which is an output signal of a transformation point detection means becomes what reflected that the hardening section arrived at the predetermined physical-properties-organization like the austenite texture in the case of steel.

[0033] In this way, the high impurity concentration of a heated member etc. can realize ideal hardening regardless of an organization by the thermo cycle built on the basis of the transformation point signal.

[0034]

[Embodiment of the Invention] The gestalt of operation of this invention is explained to a detail based on a drawing below.

[0035] Drawing 1 is the block diagram showing the hardening equipment concerning this gestalt. As shown in this drawing, the high-frequency-induction-heating machine 1 arranges probe 1c in what has the same RF induction power-source 1a as usual, and heating coil 1b. Heating coil 1b is heated by

making the alternating field formed of the high frequency current supplied from RF generator 1a act on a heated member (not shown), and making this heated member generate an eddy current. Probe 1c is arranged near the heating coil 1b so that the magnetic flux generated according to the eddy current of a heated member may be detected as an electrical potential difference and quantity of electricity of a current. This probe 1c can specifically be suitably formed by the pick up coil, a hall device, etc.

[0036] Here, a heated member is steel. therefore, this -- hardening -- A2 pass the transformation point (curie point) -- A3 It continues till the transformation point, and it is necessary to heat until it becomes an austenite texture.

[0037] Then, the transformation point detector 3 is A2. Transformation point detector 3a and A3 It has transformation point detector 3b. These [A2] and A3 The transformation point detectors 3a and 3b detect A2 and A3 transformation point, respectively. Namely, electrical signal S1 which is an output signal of probe 1c Electrical signal S2 rectified and acquired with a rectifier 2 It inputs and is this electrical signal S2. They are A2 and A3 by detecting the point which is the sudden change section and serves as the maximum. The transformation point is detected, respectively and they are A2 and A3. A2 showing the transformation point, and A3 The transformation point signal S3 and S4 It sends out, respectively.

[0038] In this gestalt, transformation point detection equipment consists of probe 1c, a rectifier 2, and a transformation point detector 3.

[0039] A control section 4 is a control signal S5, S6, and S7. RF generator 1a, It is what begins the cooling water feeder 5 and an alarm 7, and performs general control of the hardening equipment concerned. It is especially A2 and A3. The transformation point signal S3 and S4 While suspending supply of the current over heating coil 1b by RF generator 1a by the input, it constitutes so that the cooling water feeder 5 may be controlled and cooling water may be supplied to the hardening part of steel. At this time, it is A3. Transformation point signal S4 Let time amount after suspending time amount until it suspends heating from an input, and heating until it supplies cooling water be the time amount based on the data for which it asked by observation separately so that the thermo cycle of ideal hardening could be built. For this reason, the control section 4 has memorized the data about the above-mentioned time amount.

[0040] A control section 4 is a heating initiation point in time to A3. It has memorized as data of the predetermined range which also calculated the allowed value of time amount until it continues till the transformation point by observation. An alarm 7 is operated when this time amount has not fallen within the range of an allowed value. It is because it becomes sudden heating too much with an allowed value [below], and the abnormalities in hard sides, such as omission of the iron core of heating coil 1b, can be considered with an allowed value [more than].

[0041] At this time, it is the room temperature signal S8 by the room temperature sensor 6 about the room temperature at the time of heating initiation. It carries out, and by incorporating and referring to to a control section 4, it constitutes so that the above-mentioned allowed value may be amended according to a room temperature.

[0042] Drawing 2 is the property Fig. showing the thermo cycle built by the hardening equipment concerning this gestalt. As shown in this drawing, this thermo cycle is the heating mode I, a standby mode II, and the cooling mode III. It has. For a standby mode II, the heating mode I is between the penetrating stages of the heat for which it asked by observation from a halt of energization, and the cooling mode III at the time of energization of heating coil 1b. The period which quenches steel with cooling water is supported, respectively.

[0043] the temperature characteristic of the steel with which, as for this thermo cycle, heating is started from a room temperature -- expressing -- **** -- A2 the transformation point -- until -- since it is the fixed permeability as a ferromagnetic, the temperature of a heating unit rises linearly.

[0044] A2 Temperature almost rises linearly in succession [although the R/C becomes small a little by passing the transformation point and metamorphosing], and is A3. It continues till the transformation point.

[0045] A3 Although the rate of a temperature rise decreases rapidly since steel will serve as non-

magnetic material if the transformation point is passed, heating of predetermined time for which it asked by observation in consideration of osmosis of the heat which originates in thermal conductivity is continued. Consequently, after passing through some temperature rise further, it is slowly cooled very much by the waiting mode II. Then, cooling mode III Cooling water quenches and temperature falls quickly.

[0046] At this time, a control section 4 is A3. The time amount T1 until it continues till the transformation point, and A3 The time amount T2 until it suspends heating from the transformation point, and time amount T3 of a standby mode II And cooling mode III Time amount T four It has managed, respectively. In order to detect abnormalities at the time of hardening, to stop energization of RF generator 1a, respectively, and to secure a predetermined cooling period, it is for securing a predetermined quenching period.

[0047] A2 of the steel which is a heated member in this gestalt of this The transformation point and A3 The transformation point is an electrical signal S2. A2 detected with transformation point detection equipment 3 since the maximum point was supported, and A3 The transformation point signal S3 and S4 Steel is A2 and A3 by heating. It means having reached at the transformation point, respectively.

[0048] Four is a control section A2. Transformation point signal S3 It is A3 continuously. Transformation point signal S4 They are the predetermined time amount T2, T3, and T four ignited by an input. While the cooling water feeder 5 supplies cooling water so that RF generator 1a may stop energization and, it controls to suspend this supply.

[0049] Consequently, although the thermo cycle shown in drawing 2 is realized, it quenches steel in the condition of having surely heated to the austenite texture, at this time.

[0050] Moreover, A3 When time amount until it reaches at the transformation point is not settled in the predetermined range, the alarm by the alarm 7 is emitted.

[0051] the gestalt of the above-mentioned implementation -- setting -- A3 everything but transformation point detector 3b -- A2 although transformation point detector 3a was also prepared -- this -- A3 transformation point detector 3b -- it is good. It is because what is necessary is to just be guaranteed that steel serves as an austenite texture. However, like the above-mentioned gestalt, two pieces are prepared and it is A2. Transformation point signal S3 It is A3 continuously. Transformation point signal S4 Exact A3 which is not influenced of a noise etc. by making to be inputted into the conditions of control of the back in a control section 4 It becomes detectable [the transformation point].

[0052] Moreover, if a heated member is the magnetic substance, it is not necessary to limit it to steel. It is because sudden change of an electrical signal can detect the transformation point similarly.

[0053] [Example] drawing 3 is the circuit diagram showing an example of the concrete configuration of the transformation point detection equipment 3 of drawing 1. As shown in this drawing, they are the window comparator 8, nine A2, and A3. It is for detecting the transformation point, respectively, and is an electrical signal (voltage signal) S2. An output is set to "1" when having fitted in the predetermined set point. At this time, for the set point of Vref1, Vref2 ($V_{ref1} < V_{ref2}$), and the window comparator 9, the set point of the window comparator 8 is $V_{ref1} < A2$, as it is Vref3 and Vref4 ($V_{ref3} < V_{ref4}$) and is shown in drawing 4 of drawing 7 and a same waveform. Transformation point $< V_{ref2}$ and $V_{ref3} < A3$ It has set up so that it may be set to transformation point $< V_{ref4}$.

[0054] A differential circuit 10 is an electrical signal S2. A differential value is taken, and an output signal is set to "1" when the differential value is moreover zero.

[0055] Therefore, they are A2 and A3 by taking the window comparator 8 or the AND logic of the output signal of 9 and a differential circuit 10. Transformation point signal A3 and A4 It obtains. AND circuits 11 and 12 are the things for it.

[0056] A2 and A3 The transformation point signal S3 and S4 It is outputted through OR circuit 13.

[0057]

[Effect of the Invention] As concretely explained with the gestalt of operation above, according to this invention, the transformation point signal showing having reached at the transformation point required for quality control of hardening can be acquired.

[0058] Moreover, the thermo cycle at the time of ideal hardening which can guarantee having reached at

the predetermined transformation point can be realized, without conducting destructive inspection using this transformation point signal.

[Translation done.]